Motor-Driven Pumps Executive Summary

This study provides the performance evaluation based on industry experience during the 1987 through 1998 period for motor-driven pumps (MDPs) in the pressurized water reactor (PWR) and in the boiling water reactor (BWR) risk-important (RI) systems. The objectives of component performance studies are (1) to determine the reliability of risk-important components and compare the results with estimates in probabilistic risk assessments (PRAs) and individual plant examinations (IPEs) and (2) to review the operational data from an engineering perspective to determine trends and patterns and gain insights into component performance.

MDP failure and estimated demand data was obtained from two databases. The Nuclear Plant Reliability Data System (NPRDS) provided data on component failures and surveillance test frequencies for the 1987-1995 period. The Sequence Coding and Search System (SCSS) provided engineering safety features (ESF) failure and demand data for the 1987-1998 period and some surveillance test failure data for the 1987-1995 period reported in Licensee Event Reports (LERs).

For the PWR and BWR RI systems, the MDP probability of failure on demand estimates were based on the combined ESF and surveillance test data failures and demands from SCSS and NPRDS data sources, except for the PWR residual heat removal and nuclear service water systems and the BWR residual heat removal system. For these exceptions, the surveillance test data was used because the ESF data was sparse.

The MDP probabilities of failure on demand estimates were consistent with the generic values from NUREG/CR-4550 (used as an input to NUREG-1150), with two exceptions. The values for the BWR reactor building closed cooling water system were lower than the generic values and the mean value for the high-pressure core spray system was higher than the generic values. Table ES-A lists the MDP probability of failure on demand estimates developed for the RI systems selected for this study and the NUREG/CR-4550 values.

TABLE ES-A
MDP PROBABILITY OF FAILURE ON DEMAND (1987-1998)

	LOWER BOUND	MEAN	UPPER BOUND
NUREG/CR-4550	**1.1E-3**	**3E-3**	**1.1E-2**
PWR RI SYSTEMS			
Auxiliary Feedwater (AFW)	1.2E-3	1.8E-3	2.4E-3
High Pressure Injection (HPI)	9.5E-5	3.0E-3	9.6E-3
Component Cooling Water (CCW)	8.8E-7	1.4E-3	5.8E-3
Containment Spray (CS)	8.9E-5	2.1E-3	6.5E-3
Chemical and Volume Control (CVCS)	9.9E-4	2.0E-3	3.4E-3
Nuclear Service Water (NSW)	1.5E-4	2.1E-3	5.8E-3
Residual Heat Removal (RHR)	2.0E-4	1.7E-3	4.5E-3
BWR RI SYSTEMS			
High Pressure Core Spray (HPCS)	2.5E-8	1.2E-2	6.1E-2
Low Pressure Core Spray (LPCS)	2.5E-4	1.5E-3	3.6E-3
Reactor Building Closed Cooling (RBCC)	4.2E-5	3.5E-4	9.2E-4
Essential Service Water (ESW)	1.5E-3	3.4E-3	5.9E-3
Residual Heat Removal (RHR)	5.1E-4	1.2E-3	2.2E-3

The yearly trend analysis of the MDP probability of failure on demand showed no trend for PWR and BWR RI systems, except for the PWR high pressure injection (HPI) system. The HPI system showed an increasing trend through the 1987-1995 period. The end point of the trend is still within the expected range of the generic values in NUREG/CR-4550.

The MDP mean probabilities of failure on demand used in plant-specific IPE studies were compared with the results of this study. The PWR IPE mean values were generally consistent with the results of this study and NUREG/CR-4550. The IPE mean values for BWR RI systems were also consistent with the results of this study and NUREG/CR-4550, except for the RHR and RBCC systems. Sixty percent of the IPE mean values for the BWR RHR system were higher than the RHR system value range estimated in this study. Most (approximately 89%) of the IPE mean values for the RBCC system were higher than the RBCC system value range estimated in this study.

Failure rates, as a function of component-years, varied slightly among the PWR and BWR plant age groups (three groups, of approximately equal size, from older to newer plants by commercial operations date). For PWRs and BWRs, the review of plant age groups did not show evidence of an increase in failure rates for any of the plant age groups due to aging mechanisms.

The evaluation of MDP subcomponent failure patterns demonstrated that circuit breakers were significant contributors to the MDP failures in both PWR and BWR RI systems (greater than 75%).

Failures of MDP assemblies in PWR RI systems were mainly attributed to unknown causes (43%) because a root cause analysis was generally not performed on the predominant failed subcomponent (circuit breaker). Age/wear and maintenance/procedural deficiencies together accounted for the bulk of the balance (43%). For BWR RI systems, age/wear was the predominant cause (43%), while unknown causes and maintenance/procedural deficiencies together accounted for the bulk of the balance (46%).